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**Chiodo**

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(54) **COUPLING ASSEMBLY FOR ANIMAL MANAGEMENT SYSTEMS**

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(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 435 days.

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(22) Filed: **Feb. 3, 2006**

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(51) **Int. Cl.**  
**F16D 1/00** (2006.01)

(52) **U.S. Cl.** ..... **403/350; 600/415; 324/321**

(58) **Field of Classification Search** ..... **403/322.2, 403/351, 352, 367, 371, 374.1, 374.2; 285/314, 285/315, 276**

See application file for complete search history.

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(57) **ABSTRACT**

A releasable coupling includes a male coupling portion having a frustoconical male plug portion, and a female coupling portion having a frustoconical female socket portion. The male and female coupling portions are locked together and unlocked by a bidirectional rotatable cam ring which drives one or more balls between the male and female coupling portions.

**17 Claims, 7 Drawing Sheets**

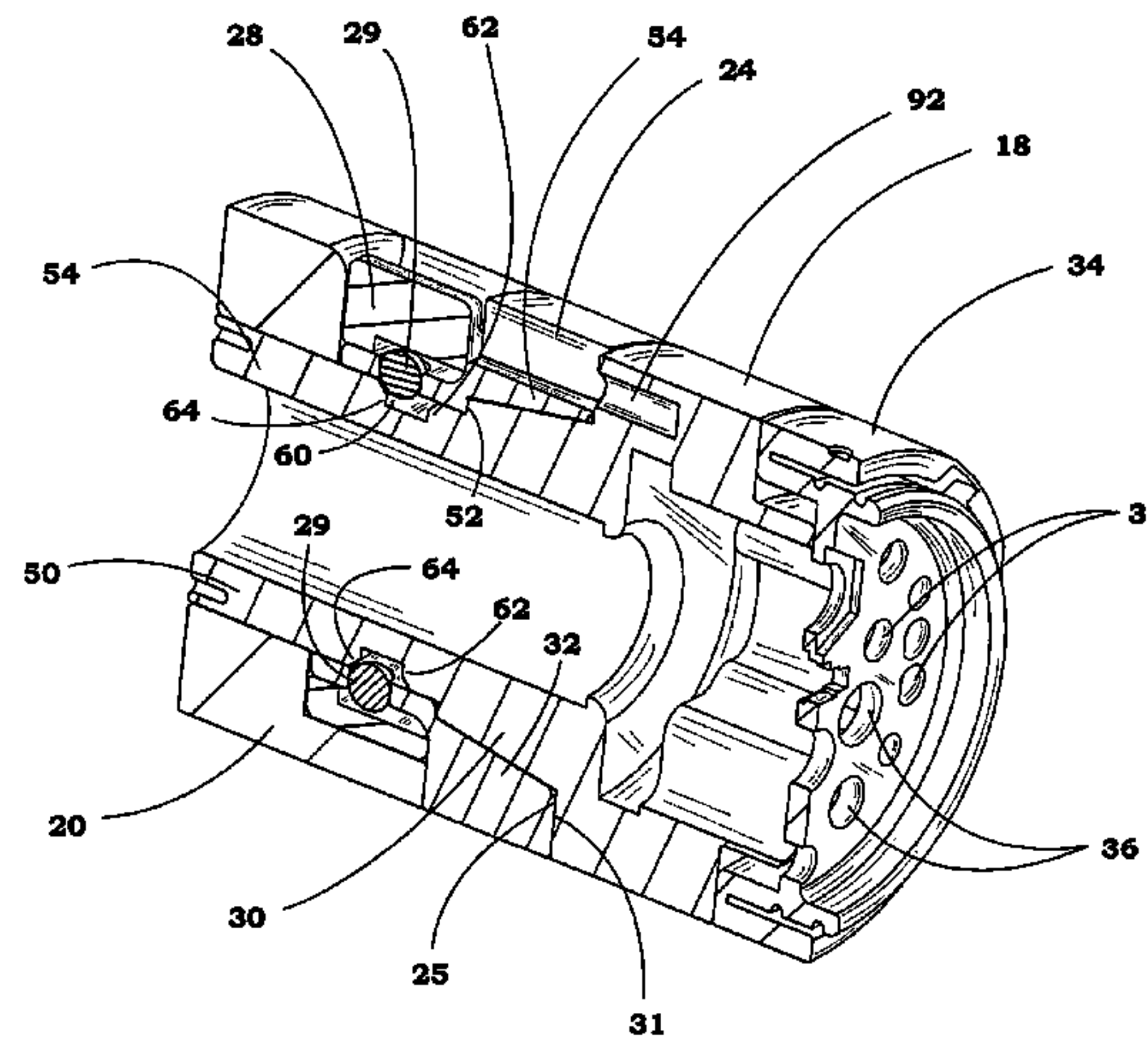
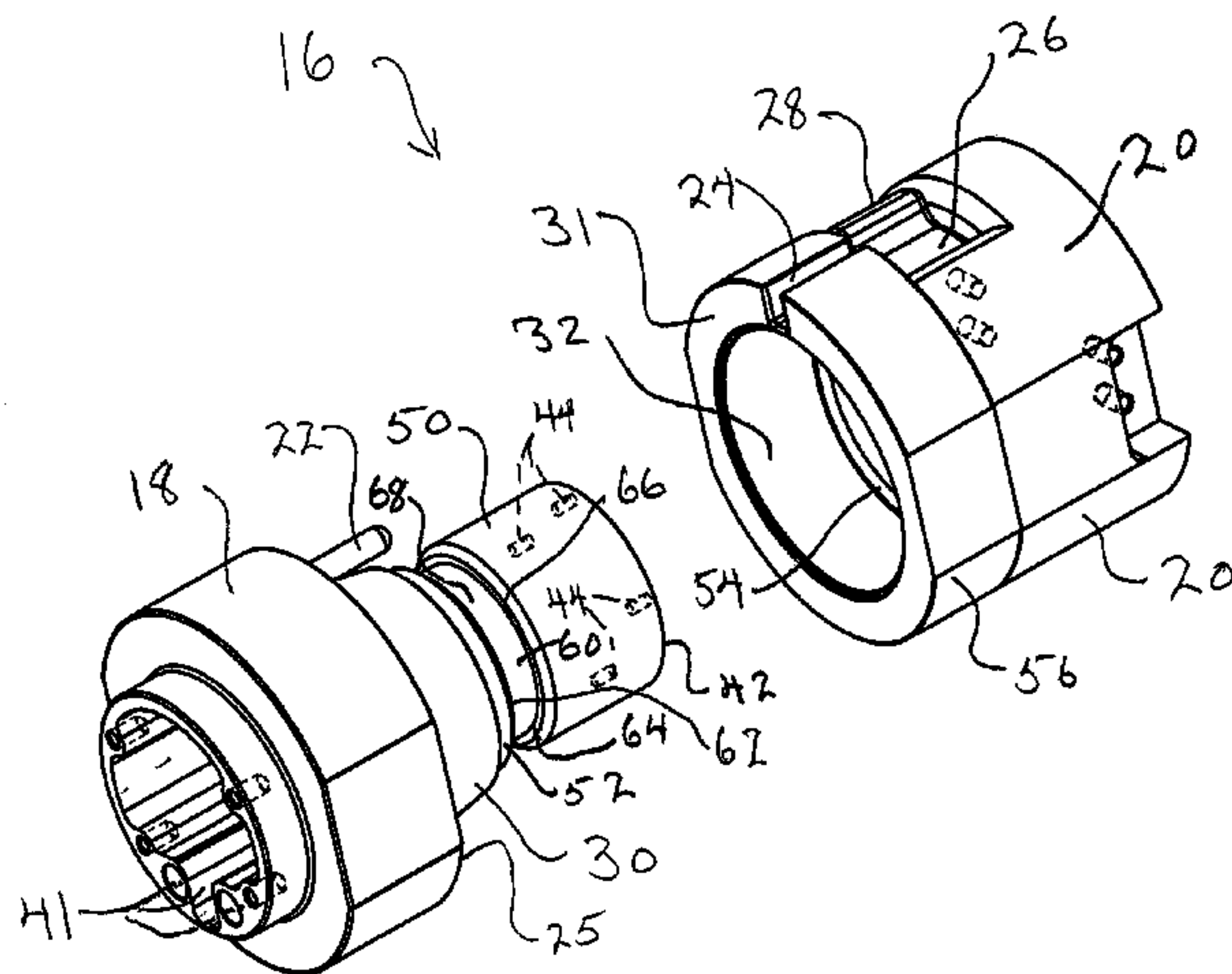
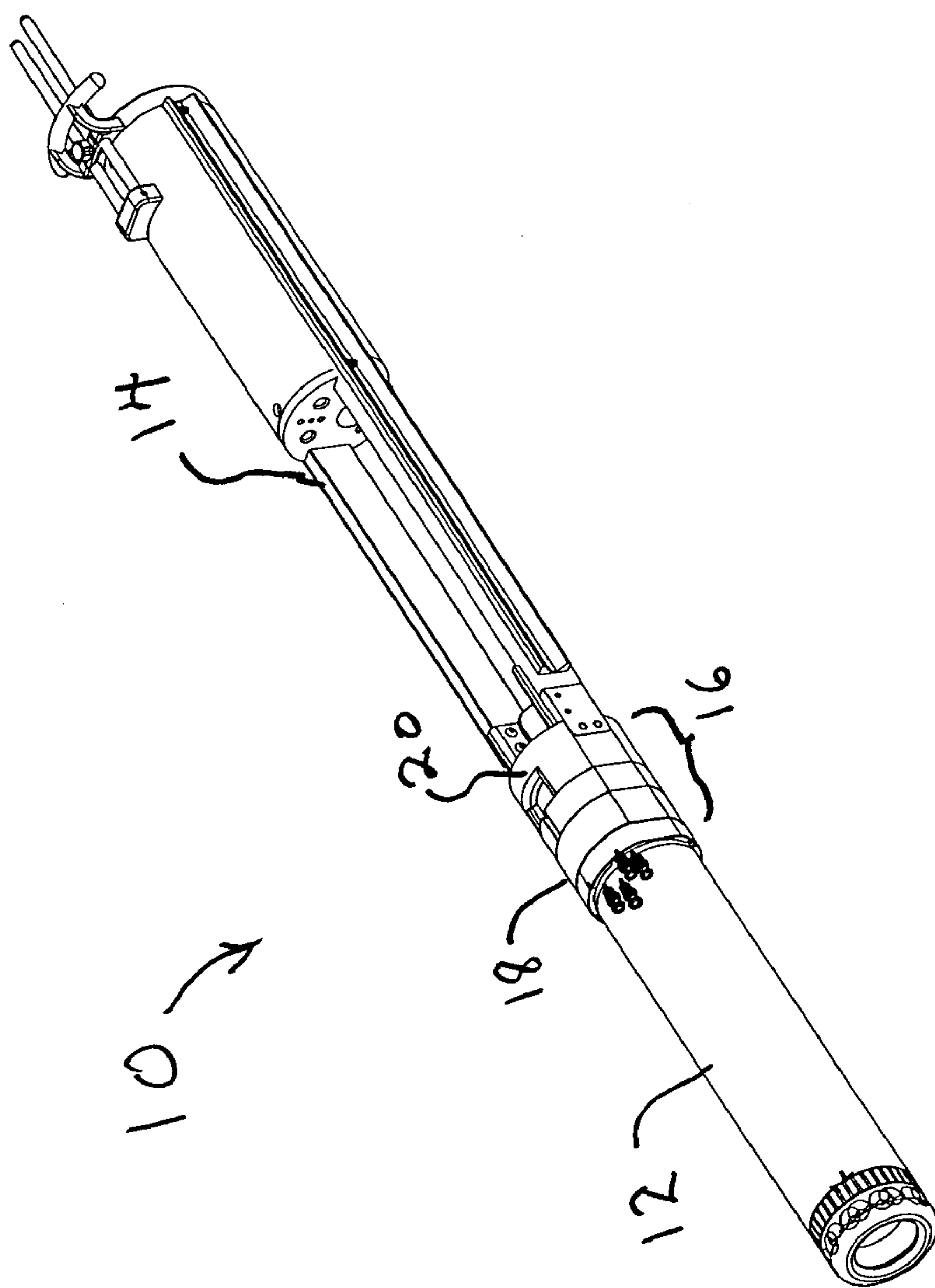




FIG. 2



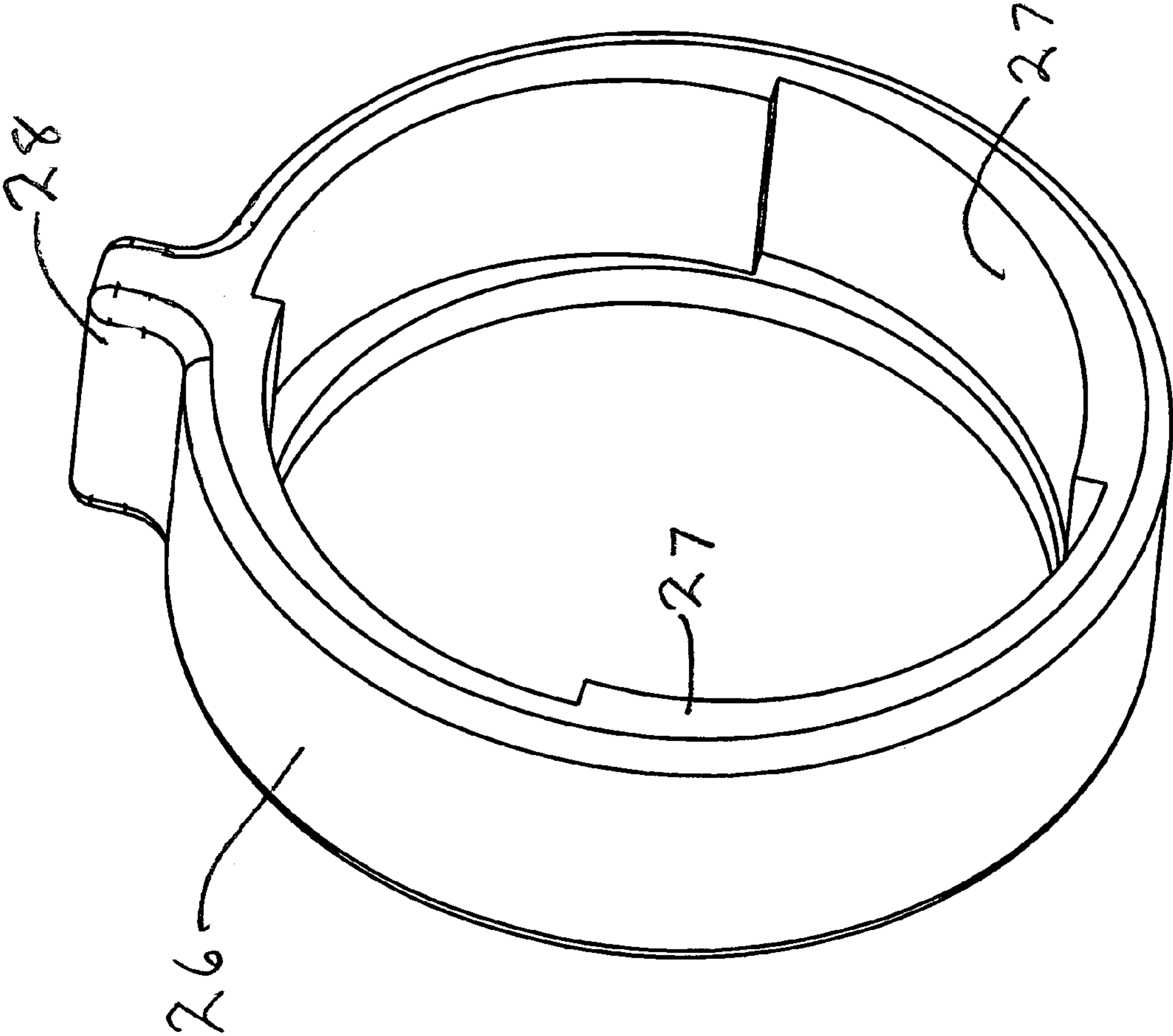


FIG. 3





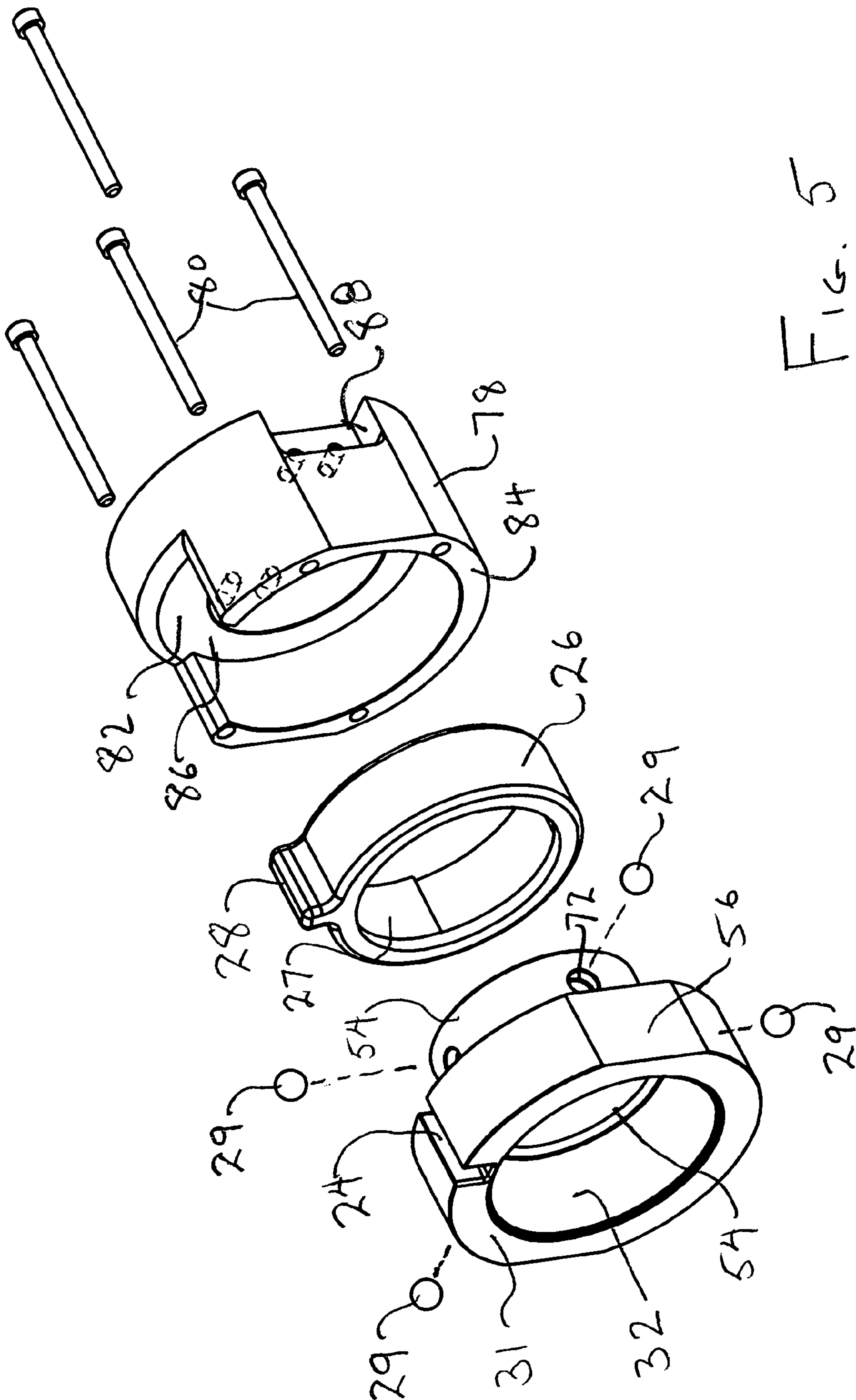


FIG. 5

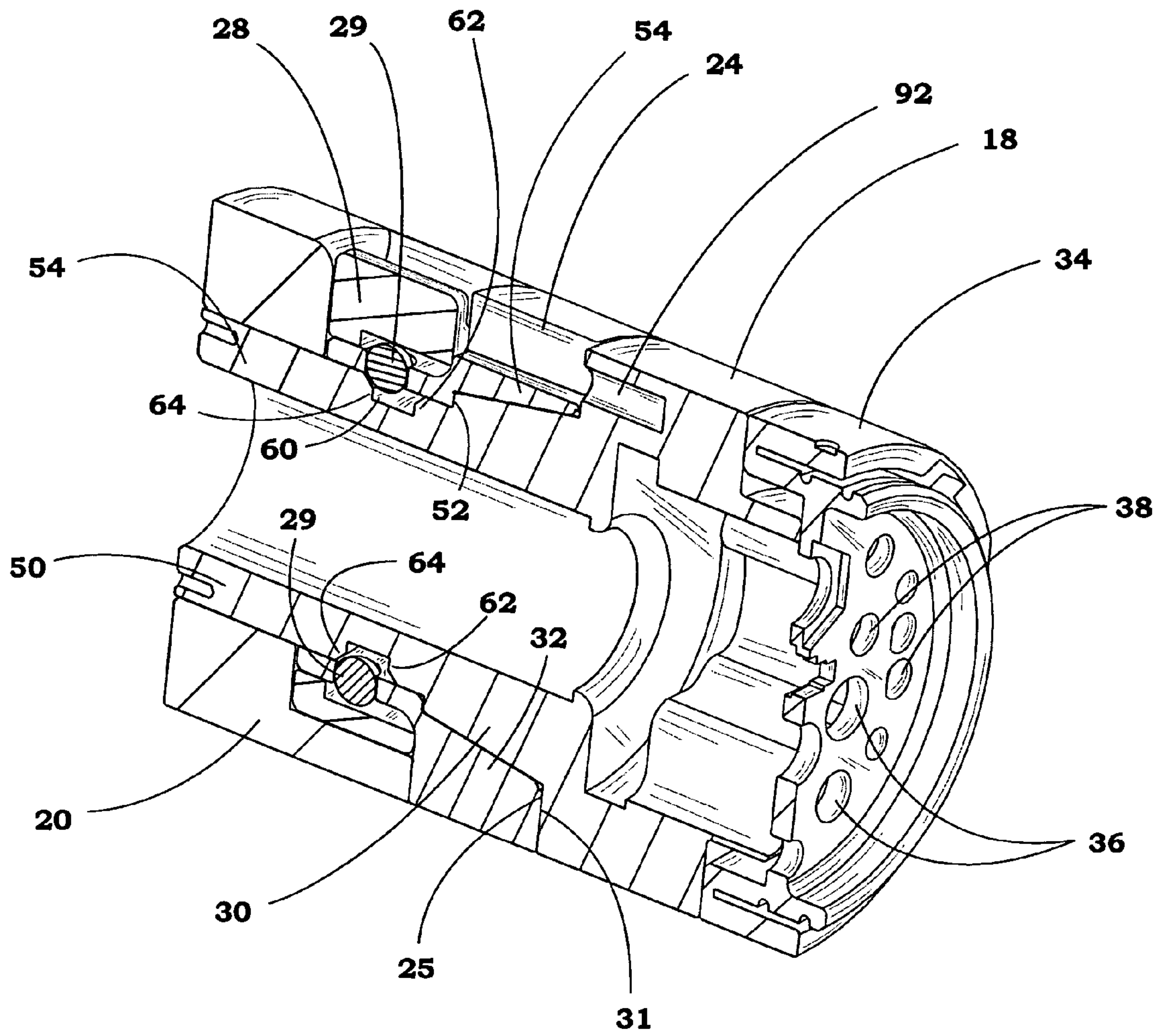


Fig. 6

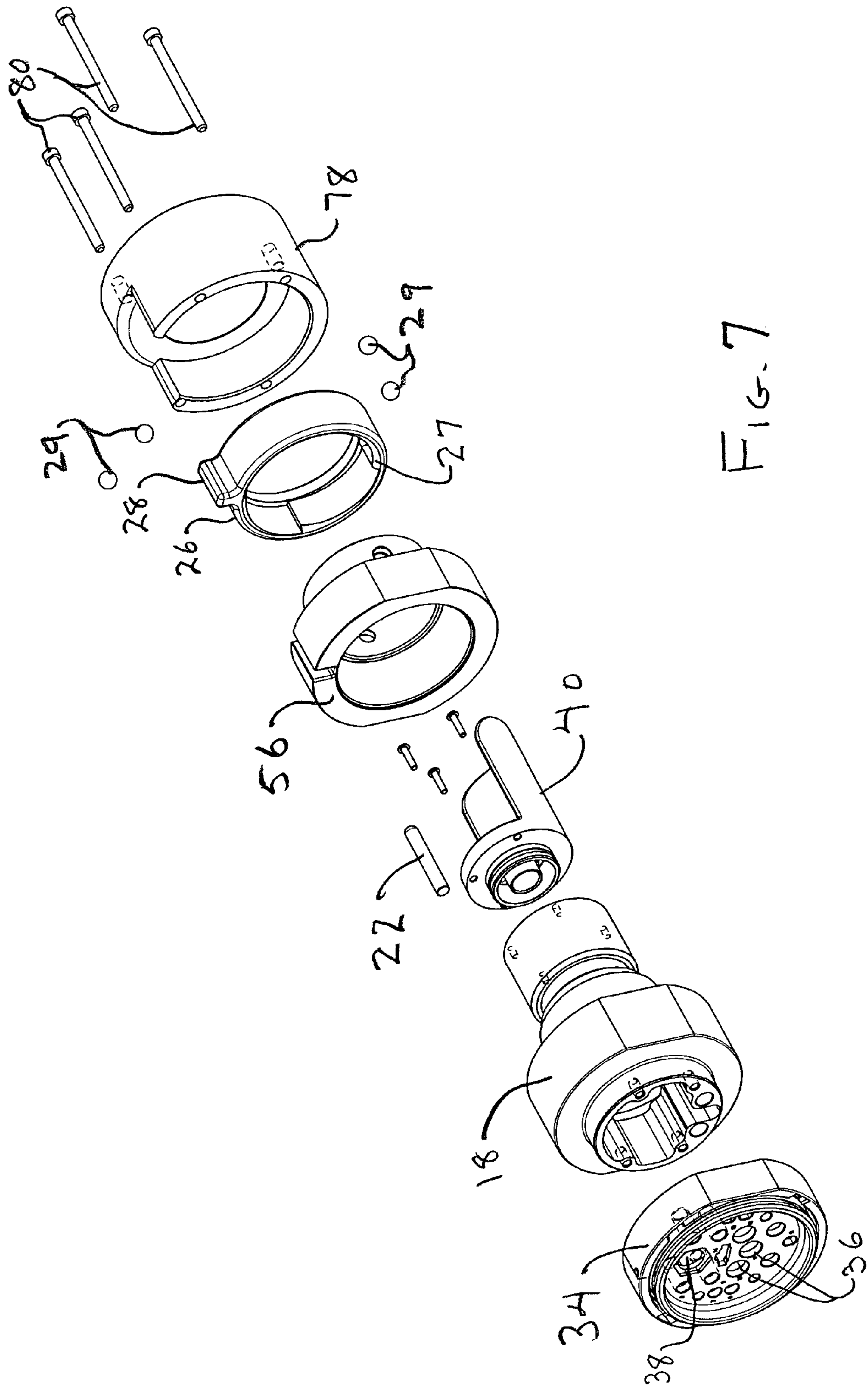


FIG. 7



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## COUPLING ASSEMBLY FOR ANIMAL MANAGEMENT SYSTEMS

### GOVERNMENT RIGHTS

This invention was made with government support under contracts 1 R41 NS050141-01 and 3 R41 NS050141-0151 awarded by The National Institutes of Health (NIH). The government has certain rights in the invention.

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates in general to couplings having male and female portions for interconnecting subassemblies, and relates in particular to a precision coupling for axially and radially securing a specimen holder to a positioning assembly for mounting a specimen, such as a laboratory rodent, in an imaging machine such as an X-ray, CAT, MRI or PET machine.

#### 2. Description of Prior Developments

Medical researchers and doctors need to study various anatomical features using different types of imaging devices such as X-ray machines, computerized axial tomography (CAT or CT) scanning machines, MRI machines and photon emission tomography (PET) machines. In order to produce images with the most detail and clarity, individual images from the various types of imaging devices are combined using sophisticated software to produce composite images.

In order to produce optimum composite images, the specimen being imaged must be accurately located within the field of view of each machine. This requires that the specimen be imaged in one machine, removed from that machine and properly located and set up in one or more additional imaging machines for additional imaging. This process can be time consuming and labor intensive.

What is needed is a method and apparatus for quickly, easily, accurately and repeatably positioning a specimen within the field of view of the same imaging machine and/or a series of different imaging machines over a period of time. A particular need exists for a convenient way to connect and disconnect a specimen holder to and from a modular receiver or positioning receiver system on one imaging machine and then connect and disconnect the same specimen holder to and from a different imaging machine without any complicated set up procedures.

### SUMMARY OF THE INVENTION

The present invention has been developed to provide an interconnection between a spacing and positioning system adapted to be connected to an imaging machine and a specimen holder which is adapted to hold and accurately position a specimen for repeatable placement in the same or different imaging machines.

The coupling includes male and female frustoconical plug and socket members. The frustoconical interconnection, coupling and resulting alignment provide both radial centering and positioning as well as axial registration and positioning along precision machined frustoconical surfaces. The male and female members or portions are axially and radially cammed into position by a rotatable cam ring acting on a circumferentially-spaced series of balls, such as ball bearings.

The cam ring can be manually-actuated or driven by an external power source. A manually-actuated screw or cam can also be used for such centering as well as an axially-actuated

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air cylinder and plunger. In any case, an axial and radial force is applied to the interface between the conical surfaces of the plug and socket members to register a positioning receiver system with the animal holder for accurate, repeatable positioning of a specimen within the field of view of an imaging machine. Nominally, a male cone portion is provided on an animal holder system, and a female cone portion is provided on the spacer assembly or positioning receiver system, however, this can be switched around if desired.

The aforementioned objects, features and advantages of the invention will, in part, be pointed out with particularity, and will, in part, become obvious from the following more detailed description of the invention, taken in conjunction with the accompanying drawings, which form an integral part thereof.

### BRIEF DESCRIPTION OF THE DRAWINGS

In the Drawings:

FIG. 1 is a perspective view of an animal management system provided with a coupling assembly constructed in accordance with the present invention and shown in a decoupled or separated position;

FIG. 2 is a perspective view of FIG. 1 shown in a coupled position;

FIG. 3 is an enlarged perspective view of the cam ring shown in FIG. 1;

FIG. 4 is an enlarged perspective view of the coupling assembly of FIGS. 1 and 2, shown in a decoupled position and with the interconnection panel removed from the male coupling portion for clarity;

FIG. 5 is an exploded perspective view of the female coupling portion of FIG. 4;

FIG. 6 is a perspective view in axial cross section of the male and female portions of the coupling assembly of FIG. 1 in a fully engaged position; and

FIG. 7 is a perspective exploded view of the entire coupling assembly.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be described in conjunction with the drawings, beginning with FIG. 1 which shows an animal management system or specimen positioning system **10** including a coupling assembly constructed in accordance with a first embodiment of the invention. The positioning system **10** is adapted for use in an MRI positioning assembly such as disclosed in US patent application publication number US 2005/0027190A1, filed Aug. 10, 2001, under application Ser. No. 10/631,226, and which is incorporated herein by reference in its entirety.

While the specimen positioning assembly in U.S. 2005/0027190, now U.S. Pat. No. 7,414,403, provides for a unitary specimen positioning assembly, the present invention provides for an equivalent modular, easily decoupled multicomponent positioning system. That is, the positioning system **10** of the present invention includes a detachable modular specimen holder or animal holding system **12** which is quickly and easily removably and selectively mountable on a positioning receiver assembly **14**. In U.S. 2005/0027190, now U.S. Pat. No. 7,414,403, the animal holding system and positioning receiver assembly are not readily detachable.

A modular coupling **16**, which embodies the present invention, is provided between the animal holding system **12** and the positioning receiver assembly **14** for accurately and repeatably coupling the animal holding system **12** to the



positioning receiver assembly **14** to form system **10**, such as disclosed in U.S. patent application Ser. No. 11/346,850, filed Feb. 3, 2006, titled "SPECIMEN POSITION SYSTEM FOR IMAGING MACHINES". Coupling **16** includes a male coupling portion **18** mounted on an outer end of the animal holding system **12** and a female coupling portion **20** mounted on an inner end of the positioning receiver assembly **14**. If desired, the male and female portions **18**, **20** of coupling **16** can be reversed, as long as all other compatible systems **10** are similarly adapted.

As can be appreciated from FIGS. **1** and **2**, once the male coupling portion **18** is inserted within the female coupling portion **20**, a male keying member **22** projecting from a predetermined circumferential or clockwise position (such as 12 o'clock) on the male coupling portion **18** is inserted and guided into a complementary axially-extending keying slot **24** formed in a predetermined circumferential or clockwise position (such as 12 o'clock) in the female coupling portion **20**. This keying feature circumferentially aligns the animal holding system **12** with the positioning receiver assembly **14**. This clockwise alignment ensures proper, accurate and repeatable placement of a specimen held within the animal holding system **12** within a known axial plane within the field of view of an imaging machine.

As discussed in more detail below, once the male coupling portion **18** is almost fully inserted within the female coupling portion **20**, a cam ring or cam driver **26** with circumferentially-extending cam ramps **27** (FIG. **3**) mounted within the female coupling portion **20**, can be rotated by a cam lever or cam finger grip tab **28**. The cam ring acts as a cam driver to radially compress a circumferentially-spaced series of cams such as balls **29** loosely held within the female coupling portion **20**. This camming action on cam balls **29** axially wedges and locks a radially stepped registration surface **25** (FIG. **4**) on the male coupling portion **18** into a tight axial abutment against a front radial registration surface **31** on the front face of the female coupling portion **20**. At the same time, a frustoconical male plug portion **30** on the male coupling member **18** is pulled into and tightly seated and centered within a complimentary frustoconical female socket portion **32** formed within the female coupling portion **20**.

This conical nesting accurately and securely coaxially centers the male coupling portion **18** within the female coupling portion **20** and thereby coaxially aligns the animal holding system **12** with the positioning receiver assembly **14**. At the same time, the tight axial abutment between the male and female coupling portions **18**, **20** along registration surfaces **25**, **31** accurately axially locates and registers the animal holding system **12** with respect to the positioning receiver assembly **14**.

In order to release and separate the male coupling portion **18** from the female coupling portion **20**, an operator need only rotate or push the cam tab **28** in an opposite direction to that of the locking direction. The animal holding system **12** can then be easily removed and placed in another positioning receiver assembly **14** in a different type of imaging machine.

As further shown in FIGS. **1** and **7**, the animal holding system **12** further includes an interconnection on panel **34** which includes ports **36** for the passage of fluids such as anesthesia gasses, and electrical connectors **38** for the connection of sensors located within animal holding chamber **39**. The fluid ports **36** and electrical connectors **38** communicate with aligned bores or passages **41** (FIG. **4**) formed through the male coupling portion **18**. Panel **34** can be connected to the male coupling portion **18** with axially-extending plastic

screws, and as seen in FIGS. **6** and **7**, each of the ports **36** is formed in a panel wall extending over a central bore through the coupling portions **18**, **20**.

An optional electrical lead and fluid tube support tray **40** (FIGS. **1** and **7**) is fixed to the outer face **42** of the male coupling portion **18**, such as with plastic screws which thread into bores **44** (FIG. **4**) in outer face **42**. Tray **40** is removed from FIG. **4** for clarity. Wires and tubes supported on tray **40** pass through the coaxially-aligned central through bores or passages in the male and female coupling portions **18** and **20**. Tray **40** receives and supports the electrical wires and fluid tubes (not shown) exiting the outer end of the male coupling portion **18**. As seen in FIGS. **6** and **7**, the fluid ports **36** are smaller than the through bores in the male and female coupling portions **18**, **20**.

As further shown in FIG. **4**, the male coupling portion **18** further includes a cylindrical locking and alignment collar **50** extending axially from the smaller diameter outer or front end of the frustoconical male plug portion **30**. A cylindrical radial step **52** (FIGS. **4** and **6**) on the collar **50** is formed for receiving the cylindrical ball retainer sleeve **54** (FIG. **5**) extending from the rear portion of annular front socket member **56**.

Radial step **52** leads forwardly or outwardly into an annular locking groove **60** formed in collar **50**. Groove **60** is axially bounded by a rear wall **62** and a ramped or chamfered front wall **64**. Front wall **64** includes a small radial face **66** (FIG. **4**) adjacent the bottom of floor **68** of groove **60**. As discussed below, groove **60** coacts with balls **29** to produce a positive snap-type locking action between the male and female coupling portions **18** and **20**.

Turning now to FIG. **5**, it is seen that the balls **29** are held within stepped radial bores **72** formed in the ball retainer sleeve **54**. A small step in the form of a small radial constriction at the bottom of each bore **72** prevents the balls **29** from passing completely through each bore. While four balls **29** spaced ninety degrees apart around sleeve **54** are shown in FIG. **5**, any suitable number of balls may be used. Balls **29** may be formed of hard plastic, ceramic or glass. Nonferrous metals may also be used for balls **29**. Advantageously, all components of the coupling **16** are formed of nonferrous plastic materials so as to be suitable for use in MRI type imaging machines.

Once the balls **29** are loosely seated in bores **72**, the cam ring **26** is placed over the balls **29** and coaxially around the ball retainer sleeve **54**. A cup-shaped socket member **78** (FIG. **5**) is then placed over the cam ring **26** and tightly fixed to the front socket member **56** with plastic screws **80**.

The rear socket member **78** includes a rear annular wall **82** and a cylindrical front wall **84**. The front wall **84** has an open slot **86** for receiving and guiding the finger grip tab **28**. Mounting recesses **88** are formed in the rear wall **82** for receiving brackets **90** (FIG. **1**), to which the positioning receiver assembly **14** is attached.

As can be seen in FIG. **6**, when the male coupling portion **18** is inserted into the female coupling portion **20**, the balls **29** are aligned over groove **60**. In order to lock the male and female coupling portions securely together, the cam ring **26** is rotated so as to gradually radially drive the balls **29** against the ramped or chamfered front wall **64** of the male coupling portion **18**.

As the cam ring is rotated, the cam ramps **27** force the balls **29** further radially inwardly against wall **64**. This creates an axial wedging force against wall **64** which axially pulls the male coupling portion **18** into the female coupling portion **20**. The coupling members **18** and **20** are closely dimensioned such that when the balls **29** clear the lower or radially inner end of wall **64**, the radial registration surfaces **25** and **31** are



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tightly axially abutted against one another. At this point, the balls 29 snap down with a quick positive action along radial face 66 (FIG. 4) of groove 60 and securely seat against the floor 68 of groove 60.

At this point, the coupling 16 is locked together, with frustoconical surfaces 30 and 32 tightly wedged together to produce an accurate coaxial alignment between the male and female coupling portions 18 and 20. In FIG. 6, alignment pin or male keying member 22 is removed for clarity, but its mounting bore 92 is shown. Each component of the coupling assembly 16 is shown in exploded view in FIG. 7. As seen in FIGS. 1 and 2, the animal holding system 12 and animal holding chamber 39 are cantilevered from the coupling 16.

There has been disclosed heretofore the best embodiment of the invention presently contemplated. Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed is:

1. A coupling assembly releasably connecting an animal specimen holder to a positioning receiver assembly to form a multicomponent specimen positioning system, said coupling assembly comprising:

a specimen holder constructed to hold an animal in an imaging machine;

a positioning receiver assembly constructed to mount said specimen holder in an imaging machine;

a male coupling portion having an axially-extending frustoconical plug portion and mounted on one of said specimen holder and said positioning receiver assembly;

a female coupling portion having an axially-extending frustoconical socket portion and mounted to the other of said specimen holder and said positioning receiver assembly;

said axially-extending frustoconical plug and socket portions comprising precision machined surfaces machined on said male and female coupling portions;

a male keying member projecting from a predetermined circumferential position on one of said male and female coupling portions and into a corresponding slot on the other of said male and female coupling portions for aligning and fixing said male and female coupling portions in the same circumferential positions each time said male and female coupling portions are coupled so as to accurately and repeatably position and align the animal specimen in the same circumferential position; and

a driver comprising a cam member mounted on said female coupling portion; wherein said driver moves relative to the female coupling portion to drive said cam member for axially driving said male coupling portion and said female coupling portion into tight abutment with one another and applying an axial force and a radial force between said precision machined surfaces machined on male and female coupling portions so as to form said multicomponent specimen positioning system with said frustoconical plug and socket portions tightly wedged together to produce an accurate repeatable axial location and coaxial alignment between said male and female coupling portions.

2. The coupling assembly of claim 1 wherein said cam comprises a manually-actuated cam.

3. The coupling assembly of claim 2, wherein said cam comprises a ring having an internal ramp portion.

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4. The coupling assembly of claim 1, further comprising at least one plastic ball located between said male coupling portion and said female coupling portion.

5. The coupling assembly of claim 1, wherein said male coupling portion and said female coupling portion are formed with through-bores.

6. The coupling assembly of claim 1, wherein said male coupling portion comprises a locking collar.

7. The coupling assembly of claim 6, wherein said locking collar has a locking groove formed therein.

8. The coupling assembly of claim 1, wherein said male coupling portion and said female coupling portion each comprises an abutment and registration surface for abutting against one another in a locked condition.

9. A releasable coupling, comprising:  
a first coupling portion having a first frustoconical surface portion and a first central through bore;

a second coupling portion having a second frustoconical surface portion and a second central through bore;

at least one cam located between said first and second coupling portions; a driver mounted on said second coupling portion for driving said cam between said first and second coupling portions a male keying member projecting from a predetermined circumferential position on one of said first and second coupling portions and into a corresponding slot on the other of said first and second coupling portions for aligning and fixing said male and female coupling portions in the same circumferential position relative to one another each time said male and female coupling portions are coupled; wherein said driver moves relative to the second coupling portion to drive said cam so as to lock and unlock said first and second coupling portions together and to engage and disengage said first and second frustoconical surface portions; and

an interconnection panel provided on one of said first and second coupling portions, said interconnection panel having a plurality of ports formed there through allowing for the passage of fluids, wherein each of said ports is formed in a panel wall extending over said first central through bore and wherein each of said ports is smaller than said first central through bore.

10. The coupling of claim 9, further comprising a specimen holder coupled to and cantilevered from said first coupling portion, said specimen holder comprising an animal holding chamber constructed to hold a laboratory rodent.

11. The coupling of claim 9, further comprising an electrical connector mounted on said interconnection panel.

12. The assembly of claim 9, wherein said driver comprises a rotatable ring and said cam comprises a plastic ball.

13. The coupling of claim 12, wherein said rotatable ring comprises at least one circumferentially-extending ramped cam surface portion.

14. The coupling of claim 9, wherein said first coupling portion has a groove formed therein for receiving said at least one cam and said second coupling portion comprises a sleeve for supporting said driver for movement over said sleeve.

15. The coupling of claim 9, wherein said first coupling portion has a first registration surface and said second coupling portion has a second registration surface and wherein said driver and said cam drive said first and second registration surfaces into tight abutment against one another.

16. A releasable coupling, comprising:  
a first coupling portion having a groove formed therein;  
a second coupling portion having a rotatable driver coupled thereto;

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at least one plastic member movable into said groove by said driver;  
 a chamfered wall bounding said groove for guiding said movable plastic member into said groove;  
 a keying arrangement comprising a male keying member 5 projecting from a predetermined circumferential position on said first coupling portion and into a corresponding slot on said second coupling portion coupling portions, said keying arrangement providing accurate, repeatable clockwise alignment between said first and 10 second coupling portions in the same circumferential positions each time said first and second coupling portions are coupled; wherein said driver rotates relative to

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the second coupling portion moving said plastic member in and out of said groove so as to lock and unlock said first and second coupling portions together;  
 an interconnection panel provided on one of said coupling portions and having a plurality of ports formed there-through for the passage of fluids; and  
 a specimen holder cantilevered in a repeatable fixed position on said coupling and constructed to hold a laboratory rodent.  
 17. The coupling of claim 16, further comprising an electrical connector provided on said interconnection panel.

\* \* \* \* \*



UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 7,534,067 B2  
APPLICATION NO. : 11/346851  
DATED : May 19, 2009  
INVENTOR(S) : Chris D. Chiodo

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 7, lines 8 and 9, that portion of claim 16 reading “said second coupling portion coupling portions,”

Should read “said second coupling portion”

Signed and Sealed this

Twenty-first Day of July, 2009



JOHN DOLL  
*Acting Director of the United States Patent and Trademark Office*